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MODERN HIGHWAYS

A SAFEGUARD FOR LIVING...

A GUARDIAN FOR PROGRESS

GOVERNMENT DOCUMENTS
COLLECTION

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FOSTER FURCOLO
GOVERNOR

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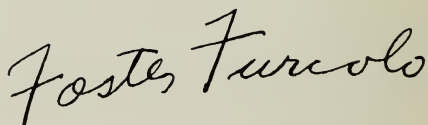
MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS

U.S. DEPARTMENT OF COMMERCE, BUREAU OF PUBLIC ROADS

Foreword

Massachusetts is proud to have been the first state to undertake an over-all, State-wide vehicular accident cost study and herewith presents the results of that study.

Commissioner of Public Works
Anthony N. DiNatale and Registrar of Motor
Vehicles Clement A. Riley and their personnel who worked jointly in the preparation of this report are hereby commended for their outstanding contribution toward a better understanding of the cause and economic effect of highway accidents.

A handwritten signature in cursive script, reading "Foster Furcolo". The signature is written in dark ink and is positioned above the printed name and title.

FOSTER FURCOLO
Governor

MODERN HIGHWAYS

A SAFEGUARD FOR LIVING...

A GUARDIAN FOR PROGRESS



Foster Furcolo

Governor

MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS

U. S. DEPARTMENT OF COMMERCE, BUREAU OF PUBLIC ROADS



The Commonwealth of Massachusetts

Department of Public Works

Office of the Commissioner

100 Nashua Street, Boston 14

His Excellency Foster Furcolo
Governor of the Commonwealth
Executive Department
State House
Boston, Massachusetts

Your Excellency:

A study by the Massachusetts Department of Public Works and the Registry of Motor Vehicles in co-operation with the Federal Bureau of Public Roads has been made to determine the actual cost of accidents on all highways in Massachusetts.

The facts obtained through this comprehensive accident cost study indicate that among the safest roads in the United States today and the safest roads to be built in Federal-Aid programs are the limited access highways.

The modern engineering design features of our limited access expressways mean utmost safety and continuous travel at reasonable speed.

The records show the urgent need for a speedy completion of the Federal-Interstate System and the reconstruction and relocation of major segments of the primary and secondary highway systems throughout the Commonwealth.

Respectfully submitted,

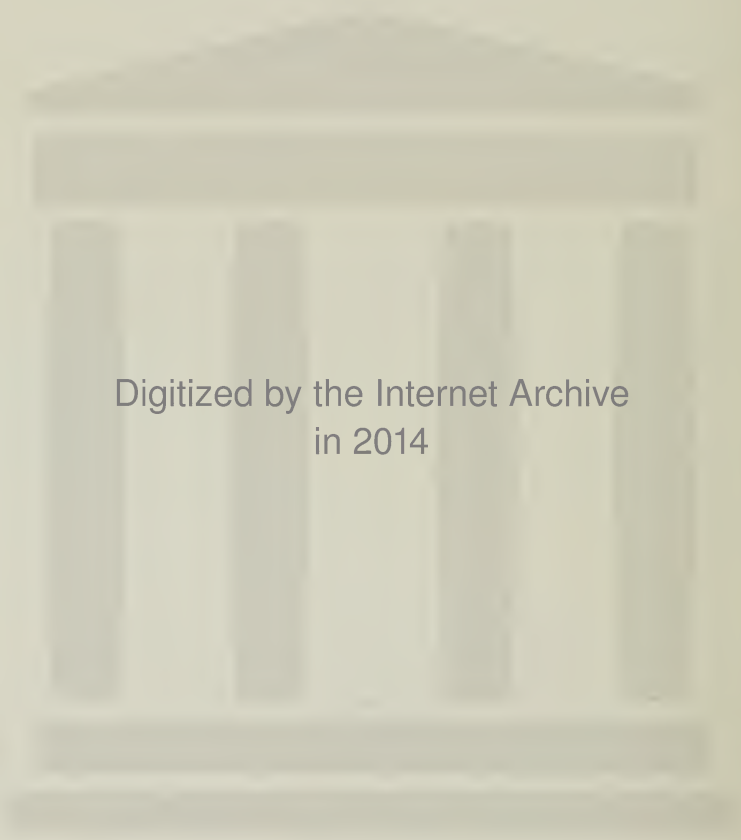
Q. N. Di Natch

Commissioner

AND:asp

PRIOR TO THE COMPLETION OF THIS INTERCHANGE
DANGEROUS CROSSROADS EXISTED THAT WERE THE
SOURCE OF A GREAT MANY ACCIDENTS. THEY ARE
NOW AVOIDED BY THIS SYSTEM OF ROADWAYS THAT
ELIMINATE HEAD-ON AND ANGLE COLLISIONS.





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INTRODUCTION

The traffic accident toll in number of persons killed and injured has been publicized so frequently that many people are quite familiar with the figures and can even relate the details of the latest fatal accident. Few persons, however, have an intimate knowledge of where, on a state-wide basis, most of the collisions are occurring, what types are most frequent and what would be the odds, as measured in number of accidents per 100 million vehicle miles, of having an accident on Massachusetts streets and highways.

The Accident Cost Study in Massachusetts was conducted by the Massachusetts Department of Public Works and the Registry of Motor Vehicles in co-operation with the Federal Bureau of Public Roads.

The purpose of this booklet is to show what this Accident Cost Study has revealed in terms of accident rates and direct costs of accidents on the six highway systems in Massachusetts and to point out where special attention should be directed in order to stem the tide of rising accident toll.

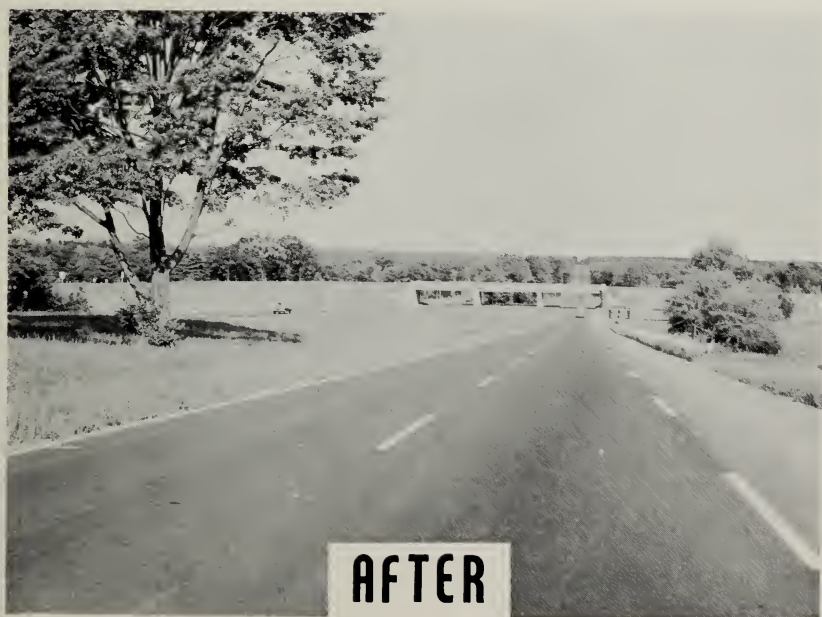
It is reasonable to expect that the conditions which prevail in Massachusetts are typical of those in most other states.

MODERN DESIGN MEANS

This blind curve was a driving hazard, and the cause of accidents which could have been prevented. The accident cost on this 1/2 mile section in one year was \$50,000.00.

The same 1/2 mile section with modern improvements. The cost was \$450,000.00. In less than ten years it will pay for itself by curtailing needless accident costs.

SAFETY, COMFORT, CONVENIENCE



General Accident Experience

The vehicle miles driven in passenger cars during 1953 on the Commonwealth's 24,506 miles of highways and streets totalled 11,628,000,000.

In this same year, Accident Cost Study figures show that 131,500 passenger car accidents occurred which resulted in a direct cost of \$50,224,000.

Under the Massachusetts law until June 30, 1953, compulsory reporting to the Registrar of Motor Vehicles included only those cases involving personal injury. On June 30, 1953 the law was revised to include the compulsory reporting of accidents in which any person was killed or injured or in which there was damage in excess of \$100 to any one vehicle or other property. The \$100 limit was raised to \$200 by another revision in the law on June 25, 1956. Registry figures in 1953 show 36,113 personal injury accidents reported, while in 1954 a total of 67,626 personal injury and property damage accidents were reported. The difference between the figures used in this booklet and the Registry figures of reported accidents is due to the large number of nonreportable property damage collisions.

Accident Experience

by Highway Systems

(Total Accidents)

Massachusetts, though densely populated in many sections, still has a low proportion of urban areas when compared with rural areas. Approximately 15% of the 8,093 square miles in Massachusetts are classed as urban and 85% as rural.

Table 1, the basic accident table, shows that 88% of all accidents in the state occur in the urban areas, whose road mileage is 6,480 of the state's 24,506 miles. This point is a most enlightening one when considering density of accidents on the various highway systems. Moreover, in the urban areas, the major trouble occurs in the 39 cities of the Commonwealth where, according to Registry of Motor Vehicles' figures in 1953, 67% of the total collisions in the state occurred.

Table 1 also furnishes a comparison of the accident experience on the State highway and local road systems. Without, for the moment, considering road mileage and traffic volumes, the 24,562 accidents on the State Highways in comparison with the 106,974 accidents on the local road system clearly shows where the chief problem in accident reduction lies. The figures in Table 1 substantiate the conclusion that special attention should be focused on the urban areas in the state and upon the local road systems, if appreciable reductions in accidents are to be effected.

Continued

The Federal Aid Systems, both Primary and Secondary, accounted for 47,681, or 36% of the 131,536 accidents. Of the 47,681 accidents, 24,080 occurred on State Highway and 23,601 on local roads.

In terms of "Severity" of accident the Property Damage class far outweighs the other two classes of accidents. Without the facts it is difficult to realize that 97,951 "property damage only" collisions occur in one year and that these comprise 75% of all accidents. Local systems account for 80% of the property damage accidents.



Accident Experience

by Highway Systems

(In Relation to Highway Mileage
and Traffic Volumes)

In the rate comparisons shown the efficiencies of the various systems in accident prevention are made evident. Tables 2 and 3 both show accident rates, Table 2 in accidents per mile and Table 3 in accidents per 100 million vehicle miles. Table 3 is perhaps of more value since it employs the widely accepted method of comparison of accident experience on highways.

Table 2 does indicate frequency of accidents. It shows that the average number of accidents per mile per year on the State Highways is 11.6 as compared with 4.7 on local roads. On these two systems their respective mileages were 2,109 and 22,397. Thus the frequency of accidents on the State Highways is more than double that on the local roads, but the State Highways constitute only 9% of the road mileage in the state.

Table 4 shows the total mileages and Table 5 the total vehicle-miles on each Highway System.

It might be noted here that 4,676 million vehicle miles of travel were recorded on the State Highways and 6,952 million vehicle miles on the local road systems.

Continued

The accident rates in Table 3 are most revealing. The figures show the following comparisons in accident rates on each system:

1. In the Federal Aid Primary System the accident rate (accidents per 100 million vehicle miles) on the State Highways is 432.17 and 1211.51 on local roads.
2. In the Federal Aid Secondary System the ratios are reversed with 1537.32 accidents per 100 million vehicle miles on the State Highways and 399.23 on local roads.
3. In the Non-Federal Aid System there is a preponderance of mileage on the local roads. There are 225.23 accidents per 100 million vehicle miles on the State Highways and 2107.50 on local roads.

A consideration of the exposure data may be helpful in analyzing the reversal of ratios in the two Federal-aid groups. The average volumes carried on each subdivision in the Federal Aid Primary System are not too different. This is also true of the total number of accidents in each subdivision. Therefore, accident rates expressed in accidents per 100 M.V.M. vary inversely with respect to mileage. The same is approximately true of State Highway and local road subdivisions in the Federal Aid Secondary System. Thus, in the Primary System, the

Continued

State highway road mileage is three times that on the local roads while its accident rate is only one third that of the local roads.

In the Secondary System, the State highway mileage is one-fourth that on the local roads and the State highway accident rate is four times that of the local roads.

These results lead to the conclusion that on an accident rate basis, the State highways in the F.A.P. System and the local roads in the F.A.S. System are doing a good job. On the contrary, the results in terms of accident rates on the local roads in the F.A.P. System and the State highways in the F.A.S. System indicate a definite need for improvement on these systems.

This need for improvement most certainly obtains in the case of the Non-Federal Aid local roads with their high accident totals, extensive mileage and high rate of accidents per 100 million vehicle miles.

Economic Costs - Total

The foregoing has been purposely confined to an explanation of accident experience and accident rates on the roadway systems. This was done in order to promote a clearer understanding of the accident picture in Massachusetts. It is a fact, however, that an important and integral part of any motor-vehicle accident-and aside from the aspect of personal injury, suffering and inconvenience involved - is the monetary cost incurred.

In this report monetary costs will be confined to "direct" costs only. "Direct" costs are defined as the money value of damages and losses to persons and property that were the direct result of these accidents and which might have been saved for the car owner had these accidents not occurred. "Direct" costs are composed of the money value of damage to property, hospitalization, doctors, dentists, and nursing service, ambulance use, medicine, work time lost, damages awarded in excess of other direct costs, attorney's services, court fees, and other miscellaneous but small items.

The Economic Cost of Accidents in Relation to the Highway Systems is shown on Tables 6 and 7.

Table 6 covers the overall costs and Table 7 gives a breakdown showing average cost per accident on each highway system. The value of Table 7 is that it brings into sharp focus the cost to an individual of having an

Continued

accident and that the cost may vary from two hundred and three dollars, the figure for an average property damage accident, up to \$5,499 for an average fatal accident in urban areas.

For those who include among their responsibilities the improvement of accident-prone highways the overall costs of accidents on the highway systems in Table 6 are of special significance.

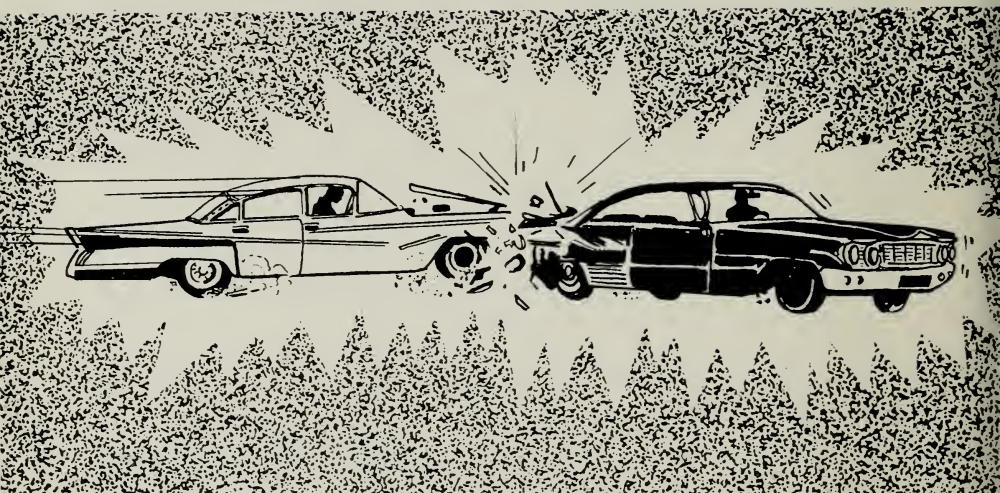
In 1953 there occurred a total of 131,536 accidents which involved \$50,223,500 in direct costs. Fatal accidents made up 3%, non-fatal injury accidents 57% and property damage accidents 40% of this cost.

Earlier it was stated that an attempt would be made to point out where special attention is needed in order to reduce accidents and economic costs. The cost breakdown by highway systems provides a means for highlighting the enormous cost of accident-prone highways.

In this cost breakdown it is interesting to examine the cost comparisons in the light of what was previously found through accident rate comparisons. This may be done in three sections as before.

REAR-END

COLLISIONS....



COST MASSACHUSETTS
MOTORISTS

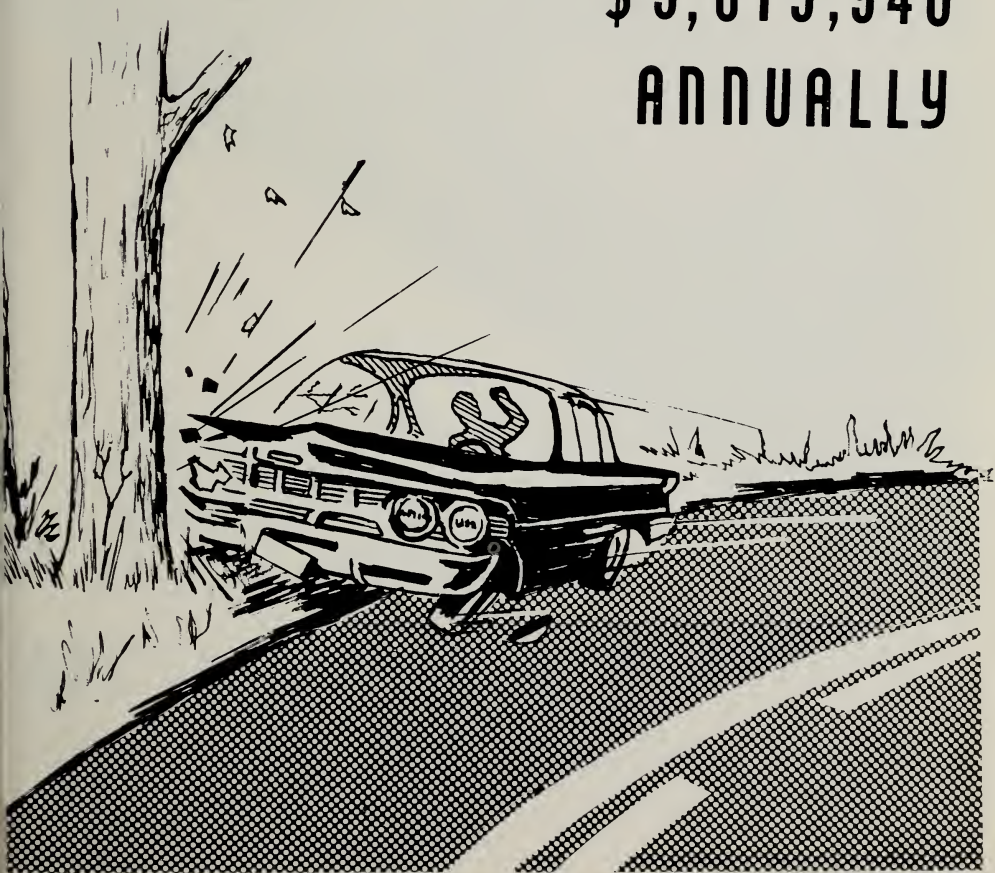
\$ 10,719,350
ANNUALLY

DRIVING OFF THE ROAD

ACCIDENTS

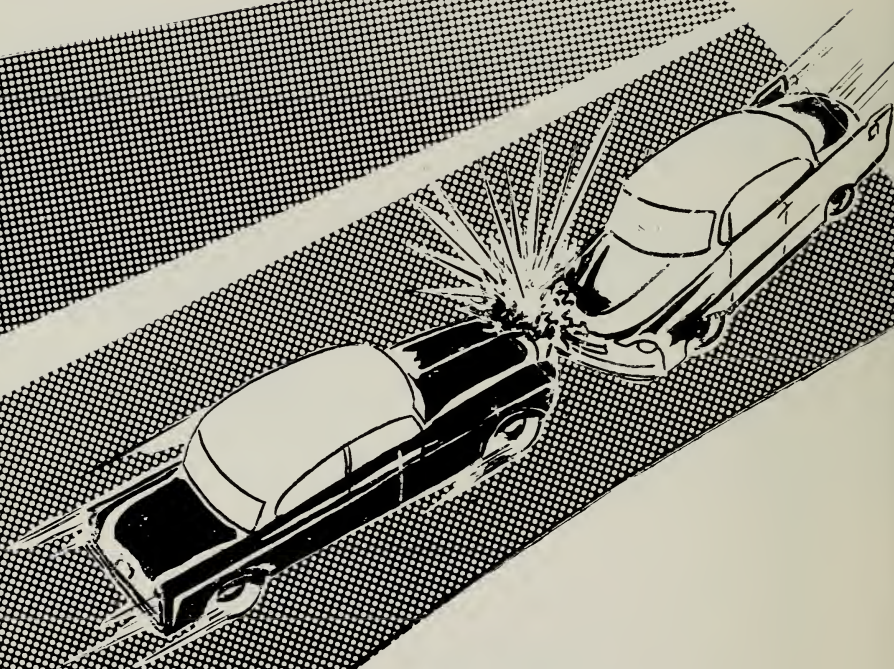
COST MASSACHUSETTS MOTORISTS

\$ 3,019,940 ANNUALLY



HEAD-ON

COLLISIONS....



COST MASSACHUSETTS
MOTORISTS

\$8,967,410

ANNUALLY

SIDESWIPE COLLISIONS....

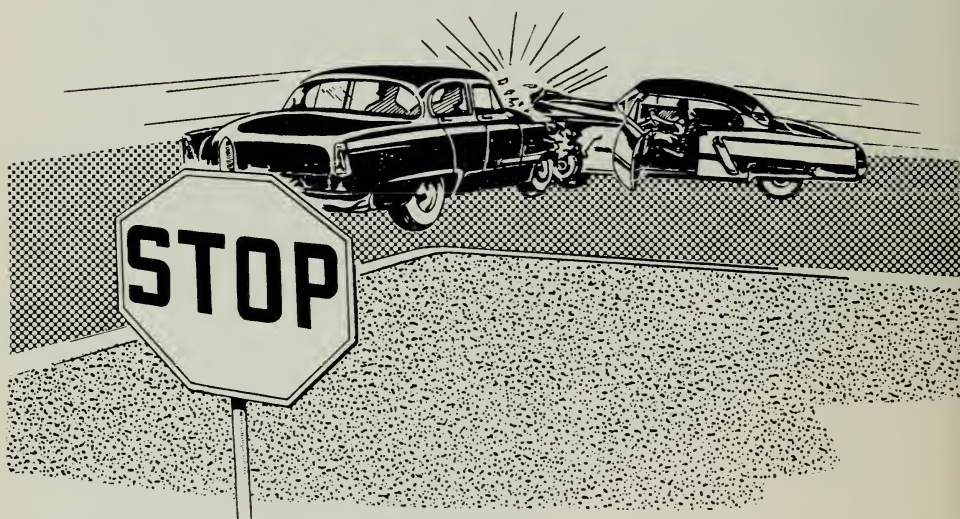


COST MASSACHUSETTS
MOTORISTS

\$2,630,970
ANNUALLY

ANGLE COLLISIONS....

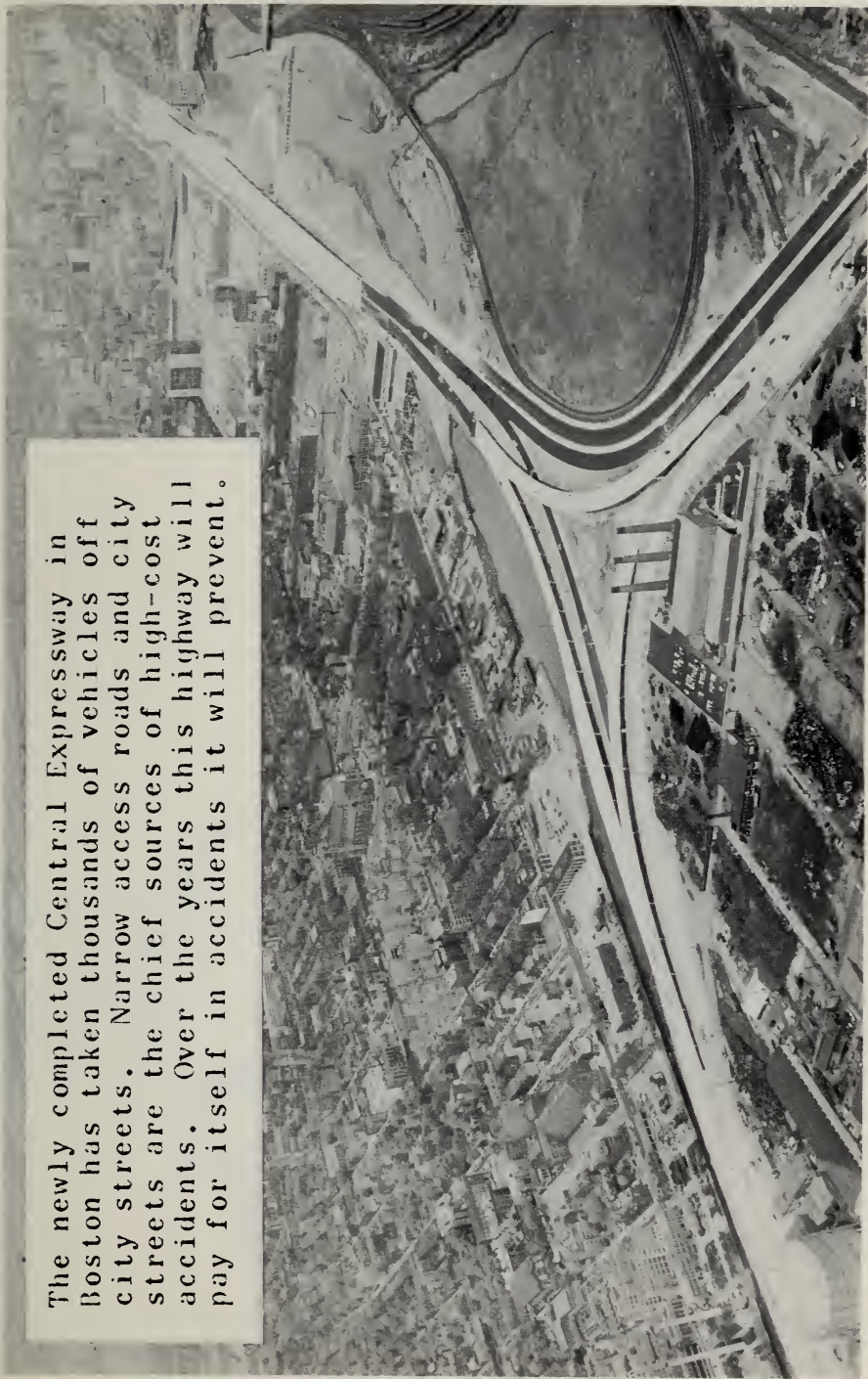
THE LARGEST SINGLE ACCIDENT-FACTOR EXPENSE

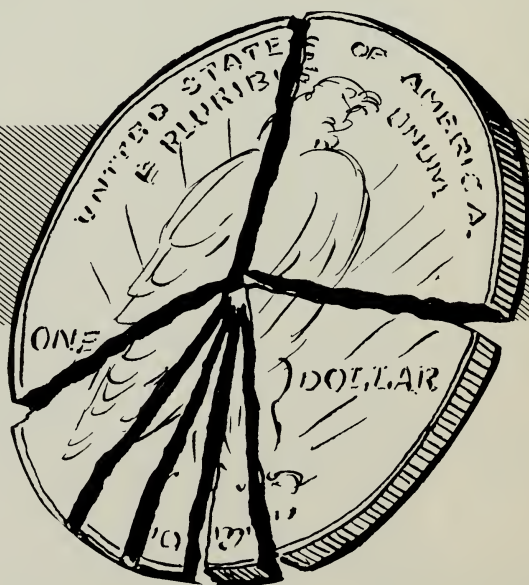


COST MASSACHUSETTS MOTORISTS

\$ 17,175,710 ANNUALLY

The newly completed Central Expressway in Boston has taken thousands of vehicles off city streets. Narrow access roads and city streets are the chief sources of high-cost accidents. Over the years this highway will pay for itself in accidents it will prevent.





Cost of Accidents by Highway System

Federal Aid Primary System.....\$17,191,940

Federal Aid Secondary System....\$5,036,540

Non Federal Aid System.....\$27,995,020

Types of Accidents

Head on.....\$8,967,410

Rear End.....\$10,719,350

Angle.....\$17,175,710

Sideswipe - same direction.....\$1,937,020

Sideswipe - opposite direction....\$699,950

Pedestrian and Non Collision....\$4,703,200

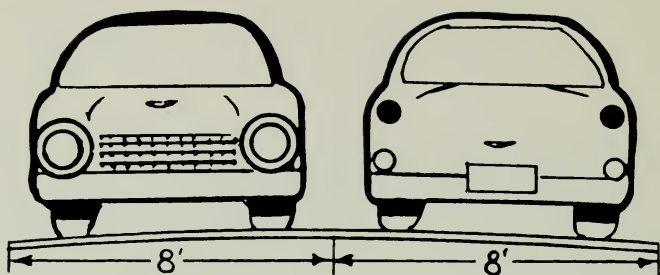
Fixed and Non-Fixed Objects.....\$3,704,890

Below is an example of poor sight-distance. This two-mile section cost the Massachusetts motorists over \$35,000 yearly in accidents.





The same highway after modern construction has eliminated many of the dangers that confront the driving public. Safe, modern highways like this, virtually eliminate the 'Head-on' accident which costs the drivers of Massachusetts over 8 MILLION DOLLARS EVERY YEAR.



Wider highways have aided immeasurably in decreasing the number of sideswipe collisions. The wider riding base allows the driver greater leeway in passing and improves his perception. Sideswipe collisions cost more than \$2,500,000

1. FEDERAL AID PRIMARY SYSTEM

State highways have a better accident rate than local roads in the ratio of 1 to 3 as seen on Table 3. However, the State highway accident costs (Table 6) exceed those on the local roads, being \$9,909,530 and \$7,282,410 respectively.

The highest costs in each subdivision of the F.A.P. System are those incurred in urban non-fatal accidents; that is, in accidents where non-fatal injuries are involved and they amounted to \$8,863,230. State and local roads each show a total cost of approximately \$4,400,000. Thus, in the non-fatal injury accident category, urban areas accounted for 52% of the total cost in the F.A.P. System while the State highways make up almost all of the cost in the rural areas.

Property damage accidents were especially costly in both rural and urban subdivisions but these costs were only 52% of the non-fatal figures.

2. FEDERAL AID SECONDARY SYSTEM

On these roads the total accident cost is only 29% of that on the F.A.P. roads or \$5,036,540 to \$17,191,940.

Here again the dissimilarity between accident rate comparisons and cost comparisons is worthy of note. On the Federal Aid Secondary System local roads have a comparatively low accident rate and State highways a much greater one in the ratio of 4 to 15. Nevertheless, the accident costs are in the ratio of only 4 to 6 on local roads vs. State highways.

Another noteworthy fact is that property damage costs are greater on the Federal Aid Secondary System than are those of non-fatal injury accidents. This is due to a preponderance of minor, less-costly accidents on the F.A.S. System.

3. NON-FEDERAL AID SYSTEM

These roads form the large network of our local streets and connecting highways. Compared with the roads in the other systems they carry less average traffic, their accident rate expressed in number of accidents per mile is less and yet because they compose 20,352 of the state's 24,506 miles they account for 83,855 accidents which cost \$27,995,020 out of the total \$50,223,500.

Non-fatal injury accidents account for \$15,974,500, property damage accidents for \$11,269,060, and fatal accidents for \$751,460 of the \$27,995,020.

Of this amount \$26,194,560 was incurred in urban areas.

Thus besides having a high accident rate in terms of accidents per 100 million vehicle miles on its local road subdivision, the Non-Federal Aid System is responsible for 56% of the monetary cost of accidents in the state.



Narrow highways, such as the one pictured above, are the source of many accidents. The partially concealed dirt access road causes many angle collisions, the most expensive type of accident. Over \$17,000,000 was spent in a single year.

**The same highway with the
blind access road made an
overpass. This construction saved
lives and thousands of dollars
that were spent on the angle
collisions, now eliminated.**



Economic Costs - Rates

The total costs of accidents on each highway system, shown on Table 6, permits a comparison of total monetary costs.

As previously noted the efficiency of a highway in terms of accidents may be obtained by comparing accident rates. This is also true when comparing economic loss expressed in accident cost rates.

Cost rates are shown on Tables 8 and 9 on Figures 2 and 3.

Figure 2 shows costs per mile of highway on each highway system and Figure 3 shows costs per 100 M.V.M.

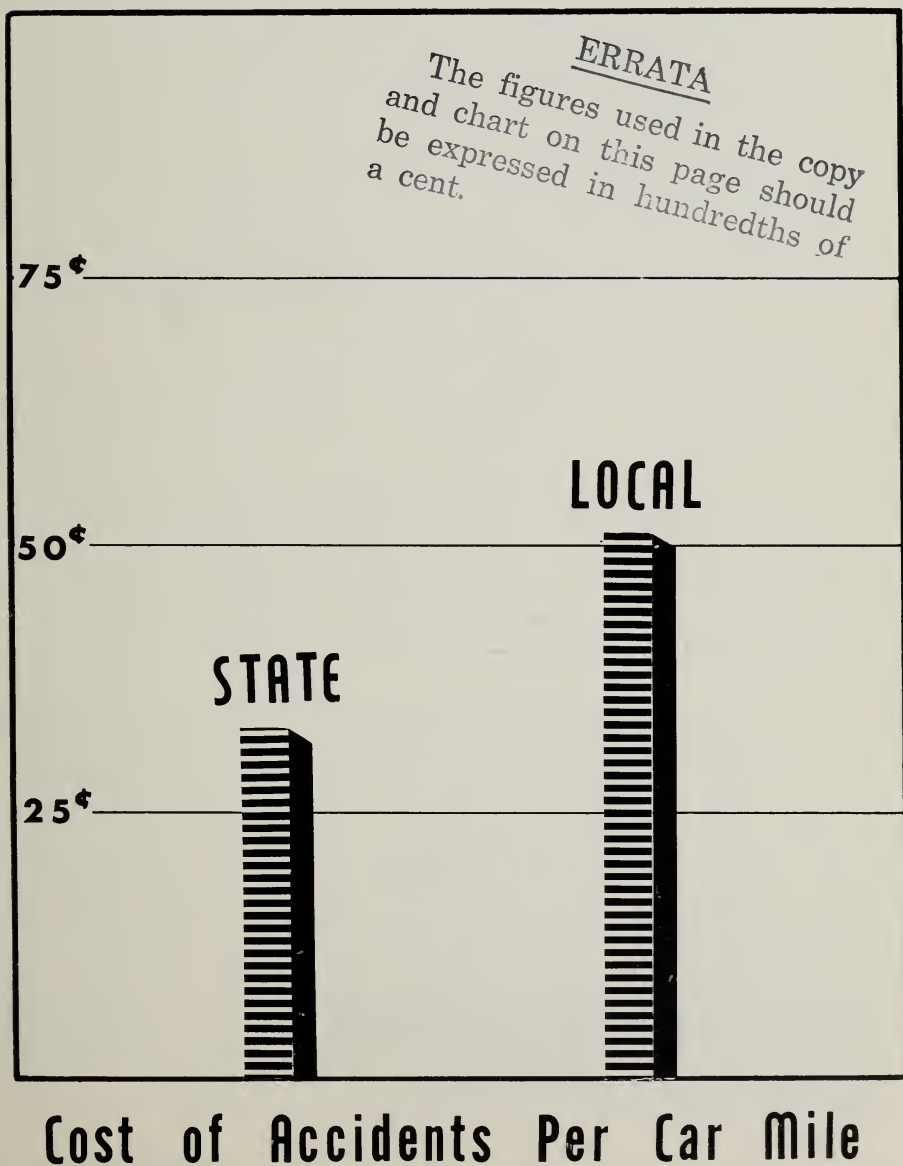
An analysis of Figure 2 indicates that the highest accident cost per mile of highway, \$16,112, is on the Federal Aid Primary local roads. Second highest is \$6,857 on Federal Aid Secondary State highways and third, \$6,537 on Federal Aid Primary State Highways. Costs per mile on the remaining systems are minor in comparison. It should be stressed here that these costs are average costs only and that costs fluctuate greatly on the many types of roadways in each system. Costs per mile, of course, present only one side of the picture and do not reflect the volumes of traffic carried.

Figure 3 shows costs on a vehicle-mile basis.

The comparison obtainable on Figure 3 may be further simplified by reducing the cost per 100 Million Vehicle Miles in dollars, to the cost per car-mile expressed in cents.

Continued

As a result of motor vehicle accidents State highways as a whole are costing Massachusetts' motorists an average of twenty-eight cents per car-mile while the local roads are costing the motorists fifty-three cents per car-mile.



Economic Cost

by Types of Collisions

The two main sections into which types of accidents may be grouped are (1) collisions between two or more vehicles and (2) accidents involving only one vehicle. These sections may be seen on Table 10. Subdivisions of the first group include Head-on, Rear-end, Angle, Sideswipe (same direction) Sideswipe (opposite direction), and other Collisions. The last group includes turning movements, parking maneuvers, and backing in traffic lane. The second main grouping includes pedestrian, fixed objects, other objects and non-collision accidents. Other objects include vehicles such as bicycles, scooters, etc.

In these two groups, 109,730 (84% of the total) are two-car accidents while 21,806 (16%) are single car accidents. Angle collisions are first in number, rear-end collisions second, other collisions third, and head-on collisions fourth.

A comparison by types of collisions on the six highway systems is also shown in Table 10. The percentage breakdowns on the State and local systems are most interesting. While rear-end collisions on each system bear about the same proportion to the total collisions in the system (17% on State highways and 17% on local roads), Angle collisions are more frequent being 23% on State highways and 44% on the local systems. Pedestrian collisions account for only 2% of the collisions on State highways against 5% on local roads. Collisions with fixed

Continued

objects are in about equal proportion, 6% on State and 5% on local roads.

The costs of the various types of accidents are shown in Tables 11 and 12. Table 11 shows total costs and Table 12 shows costs per 100 Million Vehicle Miles. Table 12 furnishes the data for Figures 4 to 9. These figures show the direct cost of (1) collisions between passenger cars or between passenger cars and other motor vehicles and (2) single car accidents.

An analysis of the results may be made by grouping them into the three main highway systems and comparing the costs per 100 M.V.M. on the State highways and on the local roads in each system.



1. FEDERAL AID PRIMARY SYSTEM

Figure 4 in the F.A.P. System furnishes a comparison of the costs per 100 M.V.M. of each of the six types of collisions in cases where two or more vehicles are involved. Figure 5 gives cost rates of each of the four types of collisions where single-vehicle accidents are involved.

Comparisons are also obtainable on the State and local road systems.

The highest cost rate on the State highways is found in head-on-collisions, with rear-end second and angle types third. On local roads the order of cost rates is angle collision first, rear-end second and head-on types third.

In the local road system several types have much higher cost rates than their respective types in the State highway System, i.e. angle types, rear-end collisions, fixed object and pedestrian types. The head-on collision cost rate is higher on the State highways.

Reduced to a cost per passenger car-mile basis, the total cost in the F.A.P. System for all types of collisions on the State highways is twenty-four cents while the local road cost rate is fifty cents.

2. FEDERAL AID SECONDARY SYSTEM

Figures 6 and 7 give the cost breakdown by types on the F.A.S. System.

The highest cost on the State highways is in rear-end collisions with angle types second, and other types third. The latter include parking maneuvers, backing, and turning movements.

The highest cost on the local roads is in angle types with rear-end second, and head-on third.

Cost rates of all types on the state roads exceed those on local roads. In terms of cost per passenger car-mile, the total cost in the Federal Aid Secondary System on State roads was sixty-nine cents as compared with thirteen cents on local roads.

3. NON-FEDERAL AID SYSTEM

Figures 8 and 9 give the cost breakdown by types on the N.F.A. System.

The highest cost on the State highways is in fixed object cases with pedestrian accidents second.

The highest cost on the local roads is in angle types and amounts to \$302,663 per 100 Million Vehicle Miles. This, incidentally, exceeds the figures on any type in any highway system by a wide margin. Second in cost are rear-end types, third head-on, and fourth pedestrian accidents. In comparing costs in each of the two highway subdivisions in the N.F.A. System, it should be stressed that the mileage on the state roads is only 155 while that on the local roads is 20,197.

The cost per passenger car-mile in the N.F.A. System on the State roads is seven cents while the cost per passenger car-mile on the local roads is seventy cents.



Economic Costs on Selected Sections of State Highways in Massachusetts

In the analysis of the accident records and economic costs on the six highway systems a general picture has been obtained on a state-wide basis.

In order also to get an idea of the economic costs on specific sections of highway it may be of interest to consider the results contained in an Accident Rate and Cost Study prepared in 1957. This study was based on the accidents reported to the Registrar of Motor Vehicles in 1955.

The purpose of the study was to determine the direct costs of accidents on two types of State highways, namely, those having no control of access and those on which access was controlled. Four highways were selected of the former type and they included 2, 3, 4 and 6-lane roads.

Five highways were of the latter type and all of these were 4-lane divided roads which had been opened to traffic since June, 1952. As part of the study, two curves, shown on Figure 10, were prepared by plotting the yearly accident cost per mile against traffic volume, Annual Daily Traffic for each of the nine sections of highway. The costs used were based on the results of the Massachusetts Accident Cost Study and were direct costs only. This chart shows a yearly saving in cost of accidents per mile

Continued

of highway of \$18,000 at 10,000 vehicles per day and \$68,000 at 25,000 vehicles per day on the controlled access roads.

It was pointed out in the study that since this was an initial attempt, future studies might alter the results obtained. Since this study was completed, a new comparison of accident costs on eight of the nine highways has become available and the figures are contained in Table 13. The 1957 records of accidents submitted to the Registry of Motor Vehicles are used in this table.

A comparison of the results in accident costs per mile with the curves on Figure 10 proved to be of special interest since volumes on the highways had changed since 1955.

In one case - Route 20, the so-called Southwest Connection, volumes had decreased substantially because of the opening of the Massachusetts Turnpike. Its accident cost per mile versus the new volume figure agrees quite closely with the curve.

Figures on the other highways are likewise quite consistent with the curves with one exception. In the volume range above 25,000 vehicles per day there is some variation from the 1955 curves. Values on the uncontrolled access roads were somewhat lower than the curve in this volume range. One explanation for this may be that the over-crowding of the free-access roads actually tends to prevent certain types of collisions.

Only one example of a controlled access highway in this high volume range was available. This was Route 128, north of Route 9. This road, though opened in 1952,

Continued

has been reaching capacity and it is now being widened and modernized. Its accident rate was 161.7 accidents per 100 Million Vehicle Miles in 1957. This was twice its rate in 1953. Its accident cost per mile had increased from \$19,100 in 1955 to \$30,100 in 1957. When reconstructed, this section of Route 128 should, without doubt, reverse this upward trend.

In summation, it may be stated that the low accident rates and costs on the controlled access highways are consistent with previous findings and that they most certainly contribute their part in maintaining a comparatively low accident rate on the State highways in the Federal Aid Primary System.



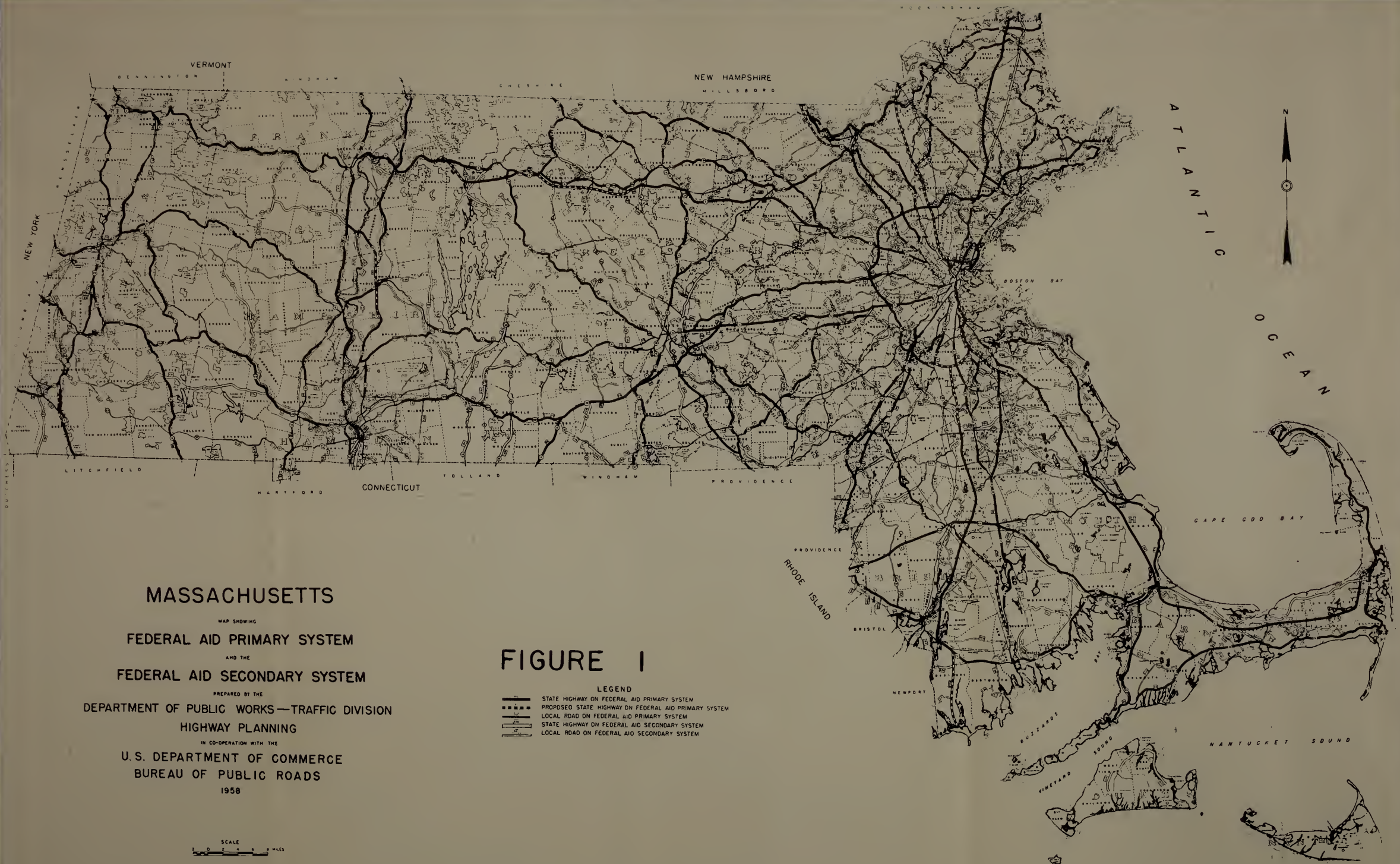


**A new expressway being cut
out of a forest wilderness.
Traffic surveys and an over-all
plan for progress called for a
new road in this section of the state.**

**The highway completed with all
safety features built right in.**

**Limited-access expressways will
save millions of dollars by
preventing accidents.**





MASSACHUSETTS

MAP SHOWING
 FEDERAL AID PRIMARY SYSTEM
 AND THE
 FEDERAL AID SECONDARY SYSTEM

PREPARED BY THE
 DEPARTMENT OF PUBLIC WORKS—TRAFFIC DIVISION
 HIGHWAY PLANNING

IN CO-OPERATION WITH THE
 U.S. DEPARTMENT OF COMMERCE
 BUREAU OF PUBLIC ROADS
 1958

FIGURE 1

- LEGEND
 — STATE HIGHWAY ON FEDERAL AID PRIMARY SYSTEM
 - - - PROPOSED STATE HIGHWAY ON FEDERAL AID PRIMARY SYSTEM
 - - - LOCAL ROAD ON FEDERAL AID PRIMARY SYSTEM
 — STATE HIGHWAY ON FEDERAL AID SECONDARY SYSTEM
 - - - LOCAL ROAD ON FEDERAL AID SECONDARY SYSTEM

SCALE
 1 0 2 4 8 MILES

FIGURE 2

DIRECT COST OF ACCIDENTS
per MILE OF HIGHWAY
BY HIGHWAY SYSTEMS

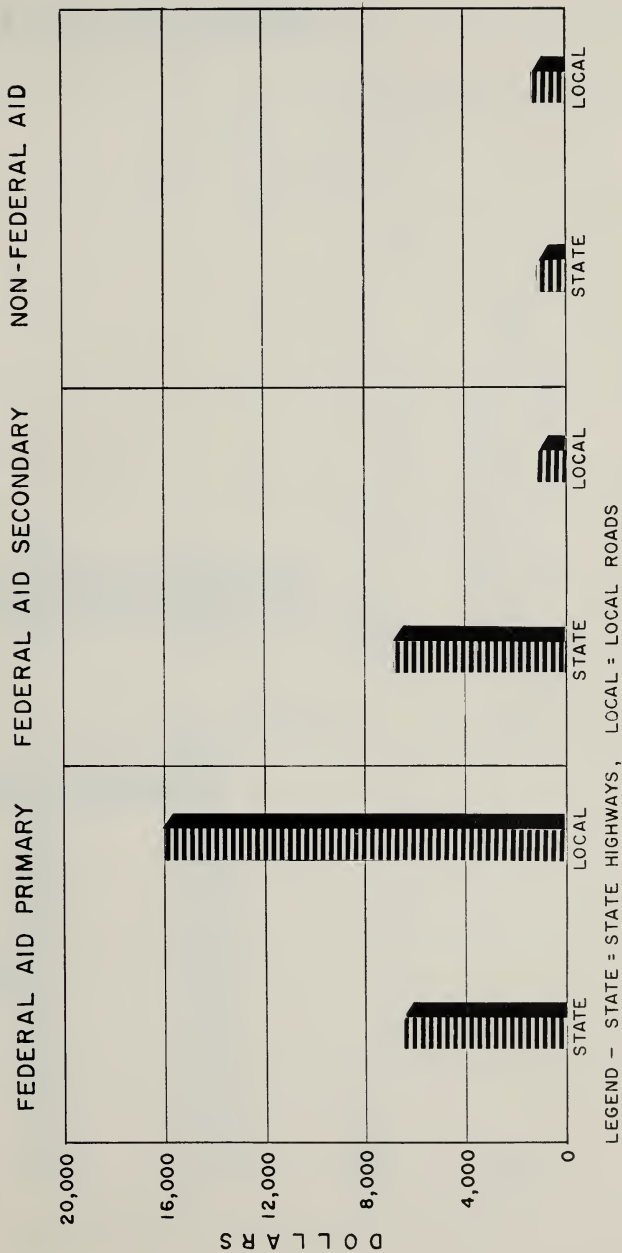
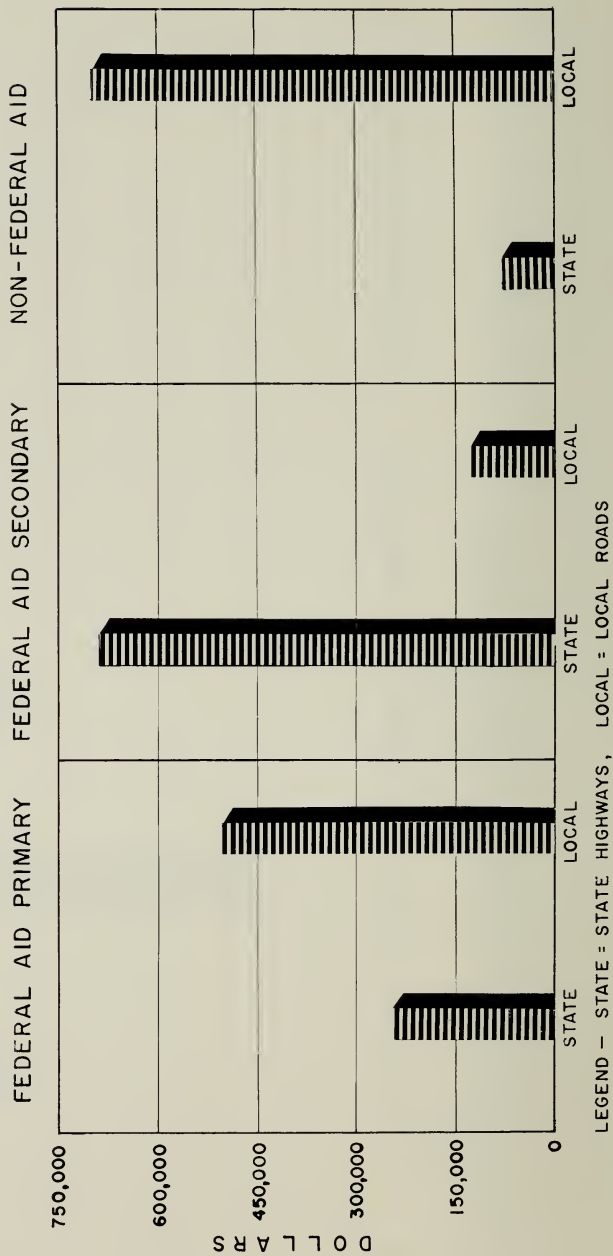


FIGURE 3

DIRECT COST OF ACCIDENTS
per 100 MILLION VEHICLE MILES
BY HIGHWAY SYSTEMS

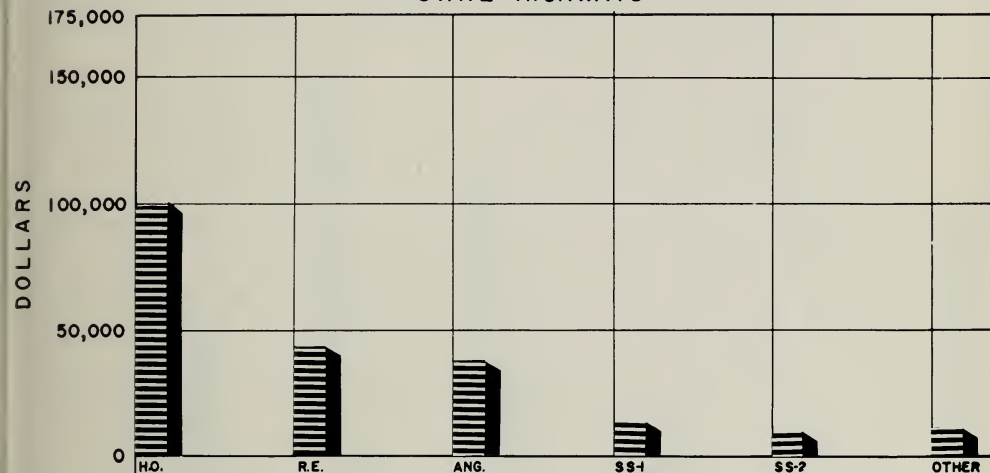


FEDERAL AID PRIMARY SYSTEM

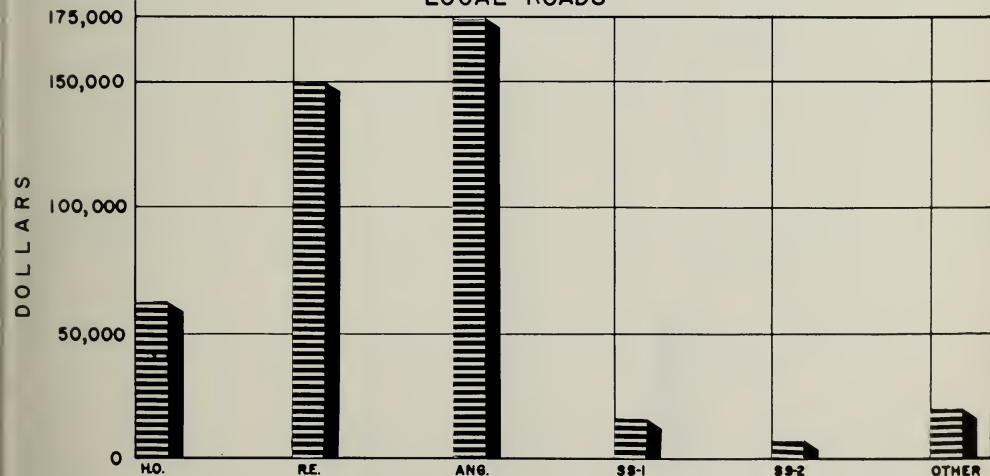
DIRECT COST PER 100 MILLION VEHICLE MILES OF COLLISIONS
 BETWEEN: a) PASSENGER CARS
 b) PASSENGER CARS AND OTHER MOTOR VEHICLES

FIGURE 4

STATE HIGHWAYS



LOCAL ROADS



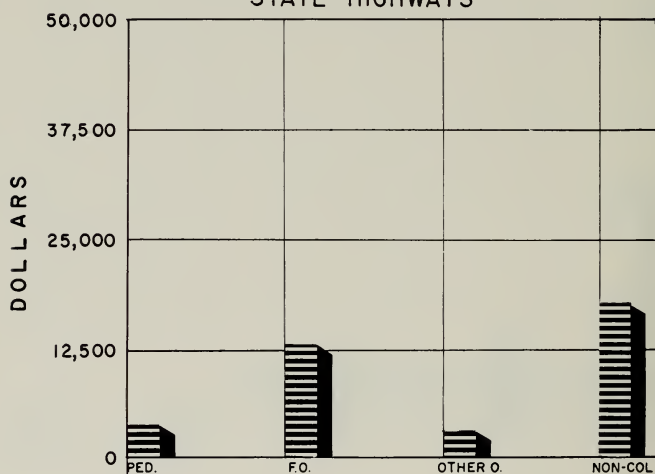
TYPES OF COLLISIONS - H.O. = HEAD ON, R.E. = REAR END, ANG. = ANGLE, SS-1 = SIDESWIPE (SAME DIRECTION)
 SS-2 = SIDESWIPE (OPPOSITE DIRECTION), OTHER = OTHER COLLISIONS

FEDERAL AID PRIMARY SYSTEM

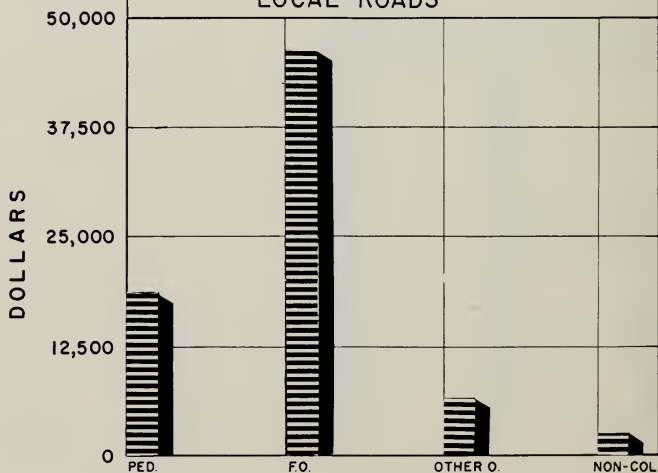
DIRECT COST per 100 MILLION VEHICLE MILES
OF SINGLE CAR ACCIDENTS
(PASSENGER CARS ONLY)

FIGURE 5

STATE HIGHWAYS



LOCAL ROADS

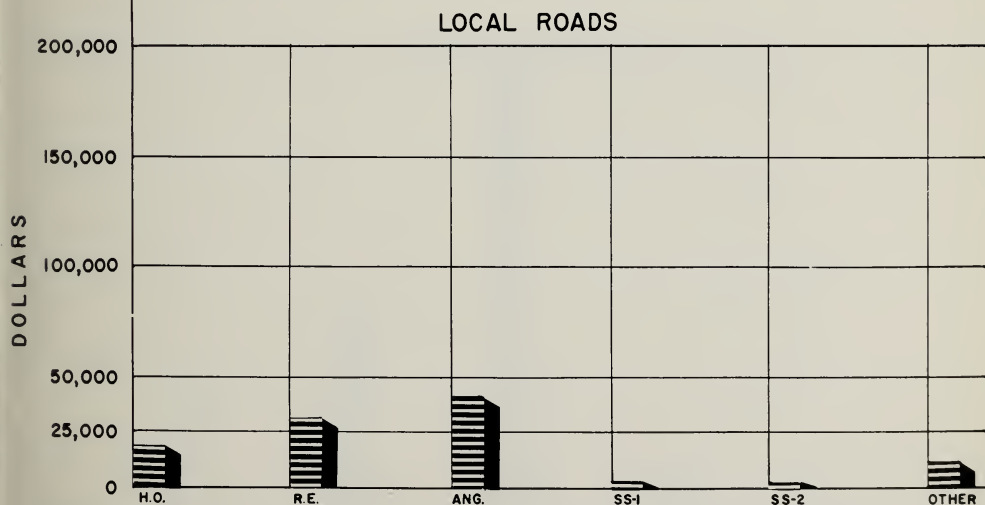
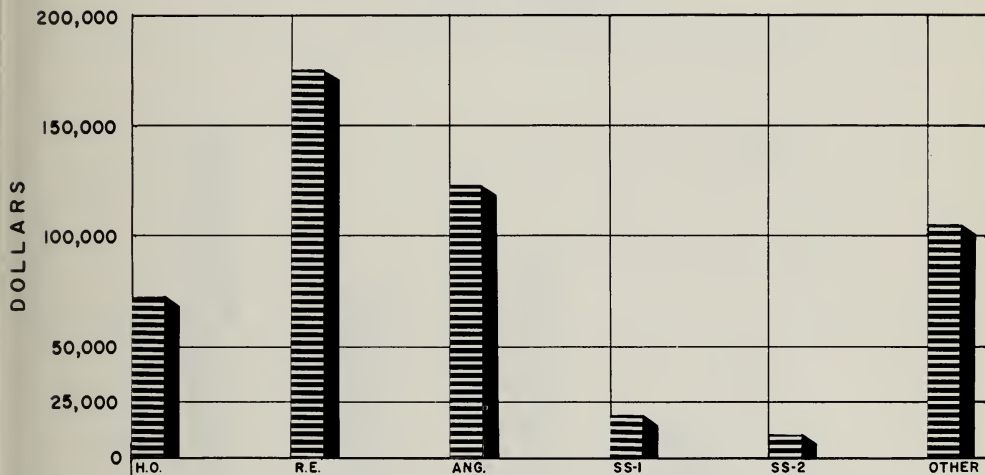


TYPES OF ACCIDENTS— PED. = PEDESTRIAN, F.O. = FIXED OBJECTS, OTHER O. = OTHER OBJECTS
NON-COL = NON COLLISION

FEDERAL AID SECONDARY SYSTEM

DIRECT COST PER 100 MILLION VEHICLE MILES OF COLLISIONS
BETWEEN: a) PASSENGER CARS
b) PASSENGER CARS AND OTHER MOTOR VEHICLES

FIGURE 6
STATE HIGHWAYS

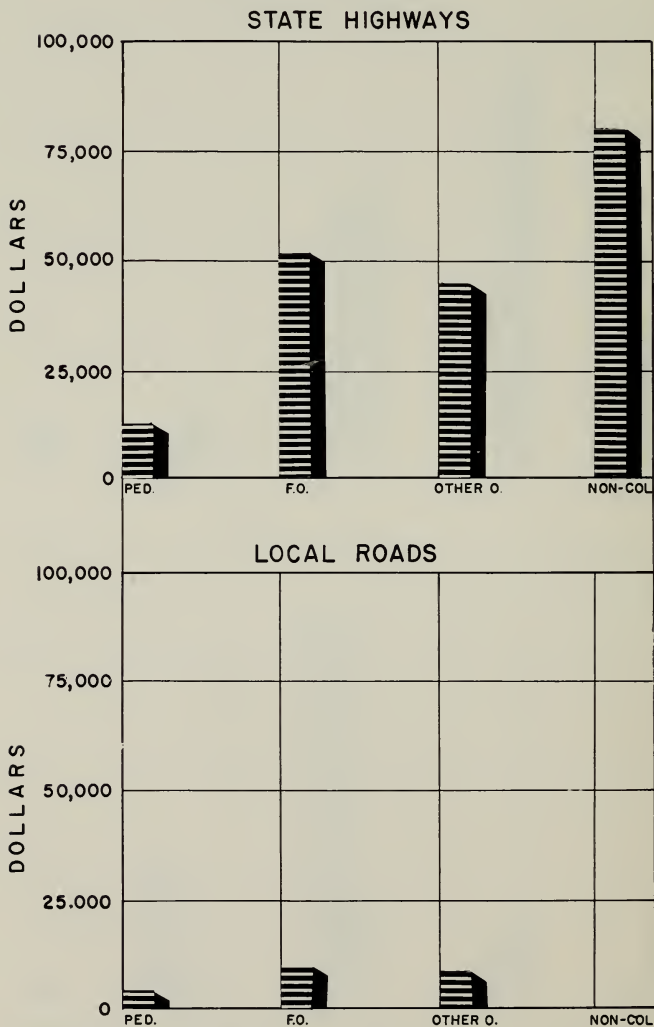


TYPES OF COLLISIONS - H.O. = HEAD ON, R.E. = REAR END, ANG. = ANGLE, SS-1 = SIDESWIPE (SAME DIRECTION)
SS-2 = SIDESWIPE (OPPOSITE DIRECTION), OTHER = OTHER COLLISIONS

FEDERAL AID SECONDARY SYSTEM

DIRECT COST per 100 MILLION VEHICLE MILES
OF SINGLE CAR ACCIDENTS
(PASSENGER CARS ONLY)

FIGURE 7



TYPES OF ACCIDENTS - PED. = PEDESTRIAN, F.O. = FIXED OBJECTS, OTHER O. = OTHER OBJECTS
NON-COL = NON COLLISION

NON-FEDERAL AID SYSTEM

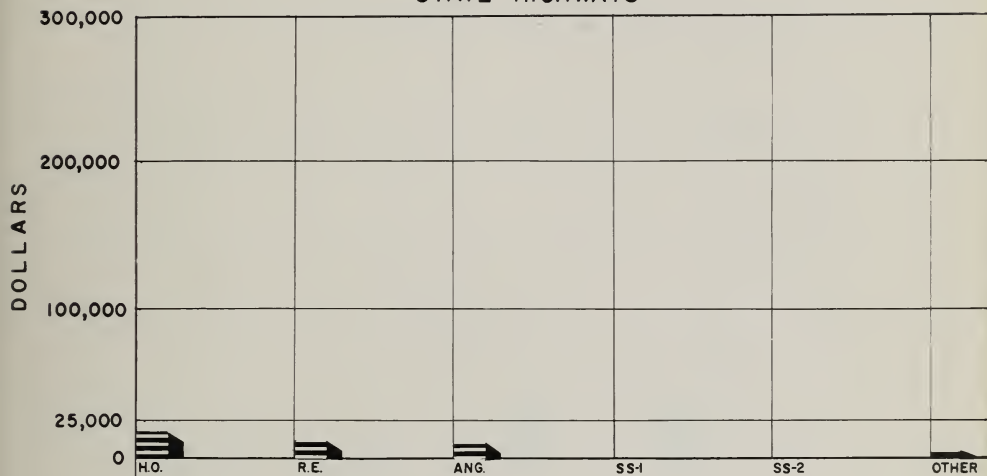
DIRECT COST PER 100 MILLION VEHICLE MILES OF COLLISIONS

BETWEEN: a) PASSENGER CARS

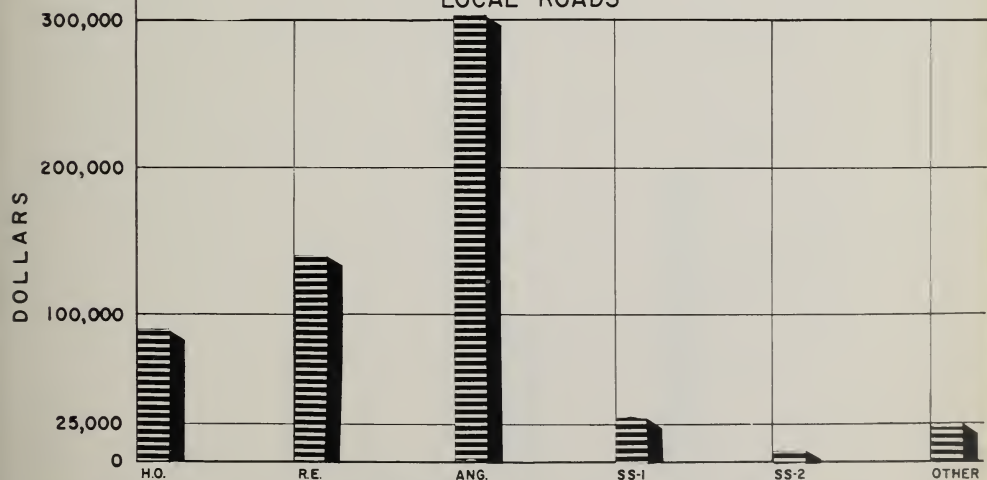
b) PASSENGER CARS AND OTHER MOTOR VEHICLES

FIGURE 9

STATE HIGHWAYS



LOCAL ROADS



*TYPES OF COLLISIONS - H.O. = HEAD ON, R.E. = REAR END, ANG. = ANGLE, SS-1 = SIDESWIPE (SAME DIRECTION)

SS-2 = SIDESWIPE (OPPOSITE DIRECTION), OTHER = OTHER COLLISIONS

NON-FEDERAL AID SYSTEM

DIRECT COST per 100 MILLION VEHICLE MILES
OF SINGLE CAR ACCIDENTS
(PASSENGER CARS ONLY)

FIGURE 9

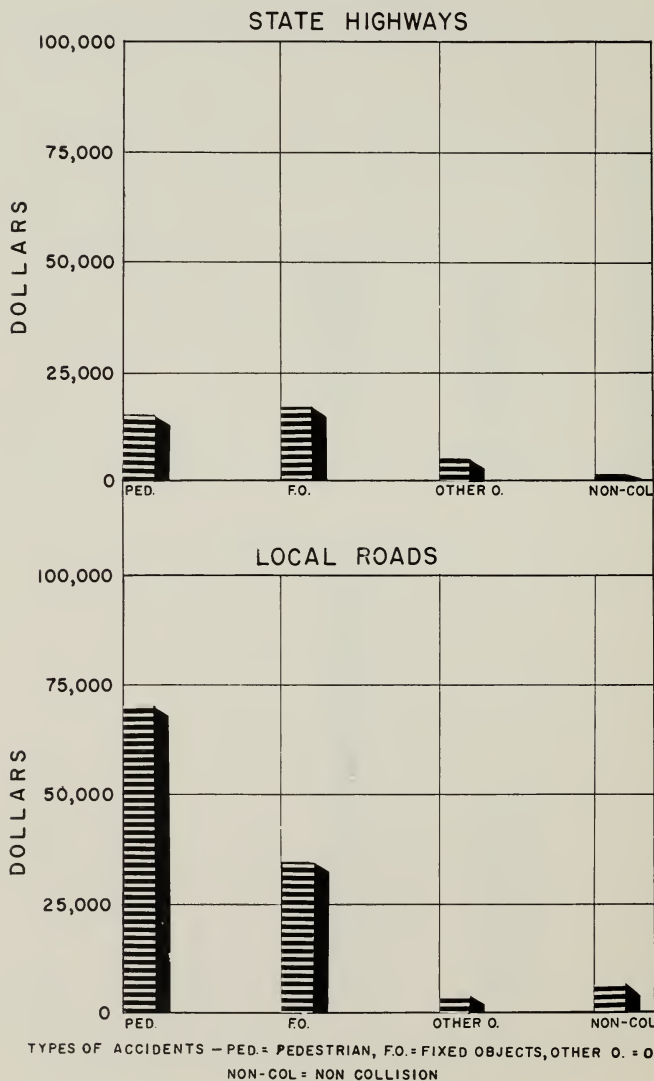
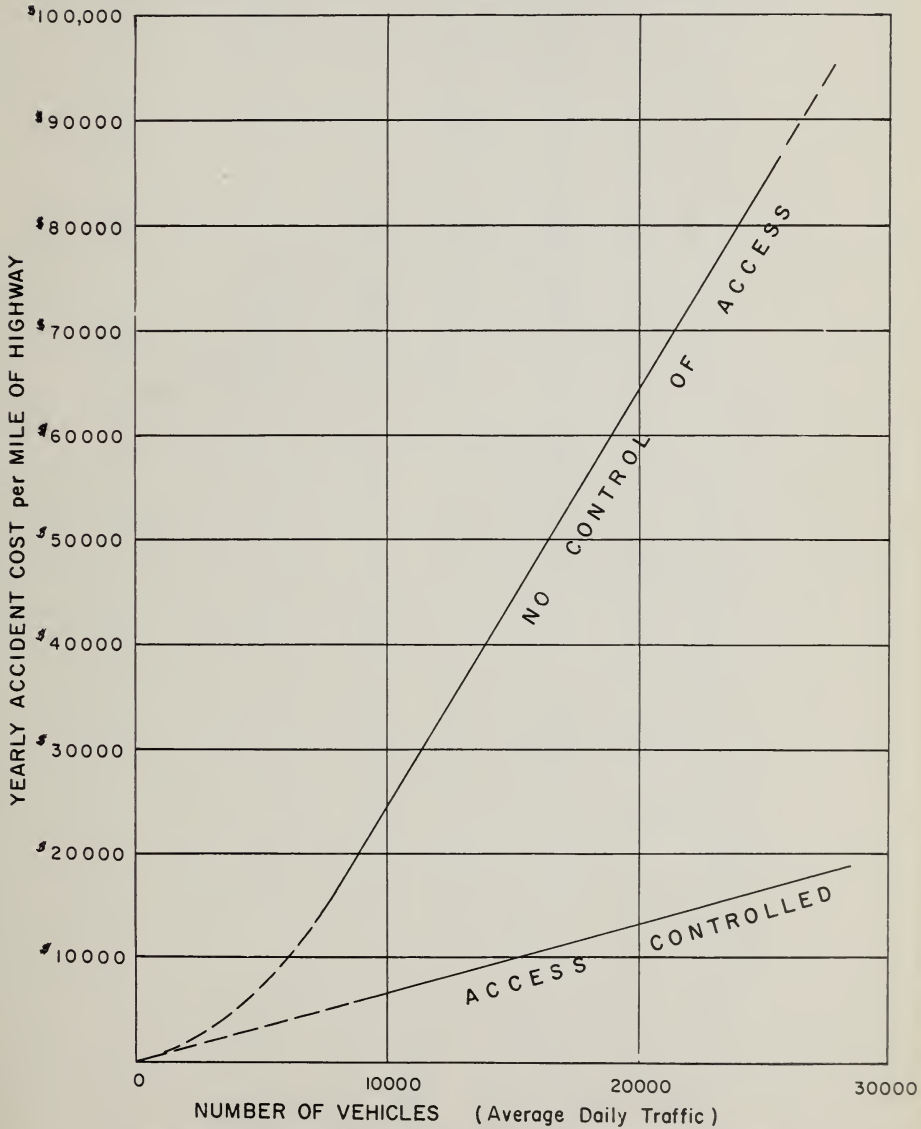


FIGURE 10

ACCIDENT COSTS ON STATE HIGHWAYS WITH
NO CONTROL OF ACCESS AND WITH ACCESS CONTROLLED



NOTE: STUDY BASED ON 1955 ACCIDENTS and VOLUMES

TABLE I

Table 1—
Motor-Vehicle Traffic Accidents by highway system and severity for passenger cars
registered in Massachusetts: 1953

Highway System	Severity of Accident											
	Fatal			Nonfatal			Property Damage					
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Federal Aid Primary System												
State Highways	40	33	73	1,903	2,219	4,152	4,481	8,703	13,184			
Local Systems	-	49	49	15	5,216	5,231	-	12,081	17,366	6,424	10,985	17,409
Total	40	82	122	1,918	7,465	9,383	4,481	20,784	25,265	6,424	28,331	34,770
Federal Aid Secondary System												
State Highways	24	5	29	576	410	986	3,257	2,399	5,656	3,857	2,814	6,671
Local Systems	24	20	44	30	1,514	1,544	-	4,676	4,676	30	6,210	6,240
Total	48	25	73	606	1,924	2,530	3,257	7,075	10,332	3,887	9,024	12,911
Non Federal Aid System												
State Highways	-	-	-	120	-	120	90	272	362	210	272	482
Local Systems	26	118	144	1,704	19,933	21,237	4,676	57,316	61,992	6,006	77,367	83,373
Total	26	118	144	1,824	19,933	21,357	4,766	57,588	62,354	6,216	77,639	83,855
Total Federal Aid State Highways	64	38	102	2,479	2,659	5,138	7,738	11,102	18,840	10,281	13,799	24,080
Total Federal Aid Local Systems	-	69	69	45	6,730	6,775	-	16,757	16,757	45	23,556	23,601
Total Federal Aid Systems	64	107	171	2,524	9,389	11,913	7,738	27,859	35,597	10,326	37,355	47,681
Total State Highways	64	38	102	2,599	2,659	5,258	7,828	11,374	19,202	10,491	14,071	24,562
Total Local Systems	26	187	213	1,349	26,663	28,012	4,676	74,073	78,749	6,051	100,923	106,974
Total All Systems	90	225	315	3,948	29,322	33,270	12,504	85,447	97,951	16,542	114,994	131,536

TABLE 4

Table 4--- Mileage by highway system in Massachusetts: 1953

Highway System	Rural	Urban	Total
Federal Aid Primary System			
State Highways	1,119	397	1,516
Local Systems	119	333	452
Total	1,238	730	1,968
Federal Aid Secondary System			
State Highways	359	79	438
Local Systems	1,301	447	1,748
Total	1,660	526	2,186
Non-Federal Aid System			
State Highways	141	14	155
Local Systems	14,987	5,210	20,197
Total	15,128	5,224	20,352
Total Federal Aid State Highways	1,478	476	1,954
Total Federal Aid Local Systems	1,420	780	2,200
Total Federal Aid Systems	2,898	1,256	4,154
Total State Highways	1,619	490	2,109
Total Local Systems	16,407	5,990	22,397
Total All Systems	18,026	6,480	24,506

TABLE 5

Table 5-- Vehicle miles of travel by passenger cars on local roads and highways by highway system in Massachusetts: 1953

Highway System	Rural Million Vehicle Miles	Urban Million Vehicle Miles	Total Million Vehicle Miles
Federal Aid Primary System			
State Highways	2,124	1,904	4,028
Local Systems	180	1,253	1,433
Total	2,304	3,157	5,461
Federal Aid Secondary System			
State Highways	303	131	434
Local Systems	762	801	1,563
Total	1,065	932	1,997
Non-Federal Aid System			
State Highways	166	48	214
Local Systems	2,370	1,868	3,956
Total	2,536	1,654	4,170
Total Federal Aid State Highways	2,427	2,035	4,462
Total Federal Aid Local Systems	942	2,054	2,996
Total Federal Aid System	3,369	4,089	7,458
Total State Highways	2,593	2,083	4,676
Total Local Systems	3,292	3,660	6,952
Total All Systems	5,885	5,743	11,628

Table 6--
Direct Costs of Motor Vehicle Traffic Accidents by Highway System and Severity for Passenger Cars
registered in Massachusetts: 1953

[illegible]

TABLE 7

Table 7—Direct Costs per Motor Vehicle Traffic Accident by highway system and severity for passenger cars registered in Massachusetts: 1953 (Derived from Tables 1 and 6)

Highway System	Severity of Accident									
	Fatal			Nonfatal			Property Damage			
	Rural Dollars	Urban Dollars	Total Dollars	Rural Dollars	Urban Dollars	Total Dollars	Rural Dollars	Urban Dollars	Total Dollars	Total Dollars
Federal Aid Primary System										
State Highways	5,361	5,447	5,400	1,009	1,969	1,539	266	227	240	599
Local Systems	-	5,482	5,482	1,920	850	653	-	211	211	418
Total	5,361	5,468	5,433	1,016	1,187	1,152	266	218	226	694
Federal Aid Secondary System										
State Highways	3,488	5,644	3,859	918	1,017	959	201	538	344	617
Local Systems	-	5,778	5,778	150	628	618	-	206	206	328
Total	3,488	5,751	4,642	880	711	751	201	319	282	390
Non Federal Aid System										
State Highways	4,092	5,467	5,218	1,120	-	1,120	60	73	70	331
Local Systems	-	5,467	5,218	699	752	746	149	184	181	334
Total	4,092	5,467	5,218	698	752	748	147	194	181	334
Total Federal Aid State Highways	4,658	5,473	4,962	988	1,822	1,420	238	294	271	603
Total Federal Aid Local Systems	-	5,568	5,568	740	800	800	-	210	210	394
Total Federal Aid Systems	4,658	5,534	5,206	983	1,090	1,067	238	243	242	471
Total State Highways	4,658	5,473	4,962	994	1,822	1,413	236	289	268	593
Total Local Systems	4,092	5,504	5,332	662	7,639	799	149	190	187	347
Total All Systems	4,495	5,499	5,212	880	860	862	204	203	203	381

TABLE 8

Table 8—Direct Costs of Motor Vehicle Traffic Accidents per mile of highway by highway system and severity for passenger cars registered in Massachusetts: 1953 (Derived from Tables 4 and 6)

Highway System	Severity of Accident											
	Fatal			Nonfatal			Property Damage			Total		
	Rural Dollars	Urban Dollars	Total Dollars	Rural Dollars	Urban Dollars	Total Dollars	Rural Dollars	Urban Dollars	Total Dollars	Rural Dollars	Urban Dollars	Total Dollars
Federal Aid Primary System	192	453	645	1,716	11,155	12,871	1,063	4,979	6,042	2,971	16,586	19,557
	-	807	807	242	13,317	13,559	-	7,659	7,659	242	21,783	22,025
	173	614	787	1,958	12,141	14,099	961	6,201	7,162	2,709	18,957	19,666
Total												
Federal Aid Secondary System	233	357	590	1,472	5,278	6,750	1,825	16,336	18,156	3,530	21,971	23,501
	-	259	259	66	2,126	2,192	-	2,154	2,154	3	4,539	4,542
	90	273	363	321	2,600	2,921	395	4,284	4,679	766	7,157	7,825
Total												
Non Federal Aid System	-	-	-	953	-	953	39	1,422	1,461	992	1,422	1,031
	7	124	131	57	2,875	2,932	46	2,025	2,071	111	5,024	1,378
	7	123	130	66	2,868	2,934	46	2,023	2,069	119	5,014	1,376
Total												
Total Federal Aid State Highways	202	437	639	1,657	10,180	11,837	1,248	6,864	8,112	3,107	17,480	18,592
	-	493	493	23	6,904	6,927	-	4,504	4,527	23	11,901	12,424
	103	471	574	857	8,145	9,002	637	5,398	6,035	1,596	14,015	15,050
Total Federal Aid Local Systems	184	424	608	240	1,596	1,836	3,523	6,708	10,231	2,923	17,021	17,944
Total State Highways	6	172	178	51	54	105	42	2,348	2,390	103	5,919	6,307
Total Local Systems												
Total All Systems	22	191	213	67	3,891	3,958	141	2,677	2,818	356	6,759	7,575

TABLE 10

Table 10-- Motor Vehicle Traffic Accidents by type of accident and highway system for passenger cars registered in Massachusetts in 1955

Type of accident	Federal Aid Primary System			Federal Aid Secondary System			Non Federal Aid System			Total Federal Aid	Total State Highways	Total Local Systems	Total All Systems
	State Highway	Local System		State Highway	Local System		State Highway	Local System		Federal Aid Systems	State Highways	Local Systems	Total All Systems
		Highway	System		Highway	System		Highway	System				
Collision with:													
One or more motor-vehicles													
Head On	2,306	1,462		631	514		15	7,751		4,913	2,952	9,727	12,679
Rear End	3,403	3,395		864	1,273		15	13,363		8,935	4,282	18,031	22,313
Angle	4,367	7,726		1,276	2,000		15	34,484		15,369	5,658	44,210	49,868
Sideswipe - same direction	1,281	1,070		150	151		-	4,397		2,652	1,431	5,618	7,049
Sideswipe - opposite direction	433	226		15	90		-	708		764	448	1,024	1,472
Other Collisions	2,129	1,333		1,086	1,050		181	10,570		5,598	3,396	12,953	16,349
Total	13,919	15,212		4,022	5,078		226	71,273		38,231	18,167	91,563	109,730
Pedestrian	201	327		248	283		30	4,759		1,059	479	5,369	5,848
Fixed objects	745	734		679	726		15	4,361		2,884	1,439	5,821	7,260
Other objects	1,751	875		1,146	153		181	2,358		3,925	3,078	3,386	6,464
Non Collision	792	213		577	-		30	622		1,582	1,399	835	2,234
Total	3,489	2,149		2,650	1,162		256	12,100		9,450	6,395	15,411	21,806
Total	17,408	17,361		6,672	6,240		482	83,373		47,681	24,562	106,974	131,536

TABLE II

Table II.—Direct Costs of Motor Vehicle Traffic Accidents by type of accident and highway system for passenger cars registered in Massachusetts: 1955

Type of Accident	Federal Aid Primary System		Federal Aid Secondary System		Non Federal Aid System			Total Federal Aid	Total State Highways	Total Local Systems	Total All Systems
	State Highway Dollars	Local System Dollars	State Highway Dollars	Local System Dollars	State Highway Dollars	Local System Dollars	State Highway Dollars	Total Federal Aid Dollars	Total State Highways Dollars	Total Local Systems Dollars	Total All Systems Dollars
Collision with:											
One or more motor-vehicles											
Head On	3,857,550	958,730	312,490	288,060	36,950	3,513,630		5,416,830	4,206,990	4,760,420	8,967,410
Rear End	1,745,000	2,140,330	761,900	690,670	20,400	5,561,090		5,137,900	2,527,300	8,192,050	10,719,350
Angle	1,496,100	2,503,180	528,330	658,060	16,500	11,973,340		5,185,870	2,041,130	15,134,580	17,175,710
Sideswipe - same direction	487,980	221,920	83,310	39,640	-	1,104,170		832,850	571,290	1,365,730	1,937,020
Sideswipe - opposite direction	339,850	97,100	43,500	33,040	-	186,460		513,490	383,350	316,600	699,950
Other Collisions	452,570	293,600	465,170	186,600	5,430	912,600		1,397,940	923,170	1,392,800	2,315,970
Total	8,379,050	6,214,860	2,194,900	1,696,070	79,280	23,251,250		18,448,890	10,653,230	31,162,180	41,815,410
Pedestrian	150,250	268,980	55,220	62,710	31,500	2,799,550		537,160	236,970	3,131,240	3,368,210
Fixed Objects	547,850	670,290	225,310	145,710	35,400	1,395,380		1,589,160	808,560	2,211,380	3,015,940
Other Objects	122,350	93,520	194,170	128,900	10,860	135,150		538,940	327,380	357,570	684,950
Non Collision	710,030	34,760	333,550	-	2,700	253,950		1,078,340	1,046,280	288,710	1,334,990
Total	1,530,480	1,067,550	808,290	337,320	80,460	4,584,030		3,743,600	2,419,190	5,988,900	8,408,090
Total	9,909,530	7,282,410	3,003,150	2,033,390	159,740	27,835,280		22,228,480	13,072,420	37,151,080	50,223,500

TABLE 12

Table 12.—Direct Costs of Motor Vehicle Traffic Accidents per 100 million vehicle miles by highway system and type of accident for passenger cars registered in Massachusetts: 1953 (Derived from Tables 5 and 11)

Type of accident	Federal Aid Primary System		Federal Aid Secondary System				Non Federal Aid System				Total Federal Aid	Total State Highways	Total Local Systems	Total All Systems
	State	Local	State	Local	State	Local	State	Local	State	Local	Dollars	Dollars	Dollars	Dollars
	Highway	System	Highway	System	Highway	System	Highway	System	Highway	System				
Collision with: One or more motor-vehicles	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars				
	95,768	66,904	72,002	18,430	17,266	88,818					72,631	89,970	68,476	77,119
	43,322	149,360	175,553	31,393	9,533	140,573					68,891	54,048	117,837	92,186
	37,142	174,681	121,781	42,102	7,710	302,663					69,535	43,651	217,701	147,710
	12,115	15,486	19,196	2,536	-	27,911					11,167	12,218	19,645	16,658
	8,437	6,776	10,023	2,114	-	4,713					6,885	8,198	4,554	6,020
	11,236	20,489	107,182	11,939	2,538	23,069					18,744	19,743	20,035	19,917
	208,020	433,696	505,737	108,514	37,047	587,747					247,853	227,828	448,248	359,610
Non Collision														
	3,730	18,770	12,723	4,012	14,720	70,767					7,203	5,068	45,041	28,966
	13,601	46,775	51,915	9,322	16,542	35,273					21,308	17,292	31,809	25,971
	3,098	6,526	44,740	8,247	5,075	3,416					7,226	7,001	5,143	5,891
	17,627	2,426	76,855	-	1,261	6,419					14,459	22,375	4,153	11,481
Total	37,996	74,197	186,233	21,581	37,598	115,875					50,196	51,736	86,146	72,309
Total														
	246,016	508,193	691,970	130,095	74,645	703,622					298,049	279,564	534,394	431,919

TABLE 13

Table 13-- Accident rates and costs on state highways in Massachusetts comparing access-controlled roads with roads with no control of access: 1957

Sections of state highway	Roads with Access Controlled										Direct Costs Per Mile
	Miles	Volume ADT	Killed	Fatal Accidents	Nonfatal Personal Injury Accidents	Property Damage Accidents	Total Accidents	Persons Injured	*Accidents 100 MPH		
Route 128 (Wellesley to Lynnfield)	24.6	32,200	3	3	257	211	468	495	161.7	\$30,100	
Route 15 (Sturbridge to Holland)	6.7	15,700	2	2	28	17	45	50	117.2	13,900	
Route 2 (Concord to Westminster)	29.4	7,600	8	4	47	58	105	117	128.7	7,220	
Route 1 (Danvers to Salisbury)	21.6	15,500	5	5	91	68	159	200	130.1	14,800	
Total	82.3	17,700**	18	14	423	354	777	862	146.2		
Route 1 (Rivers to Peabody) Route 20-1 (Northboro to Weston) Route 20-2 (Northboro to Auburn) Route 9 (Brookline to Framingham) Total	Roads with No Control of Access										79,700 9,700 21,600 78,500
	7.8	30,900	5	3	216	109	325	420	370.5		
	20.5	8,200	1	1	73	68	141	119	230.2		
	15.9	8,600	3	2	124	82	206	213	412.7		
	19.9	30,400	8	6	578	339	917	1,018	415.3		
	64.1	17,900**	17	12	991	598	1,589	1,770	378.4		

* ACCIDENTS PER 100 MILLION VEHICLE MILES ** WEIGHTED AVERAGE

Conclusion

This study of the Economic Cost of Motor-Vehicle Traffic Accidents emphasizes the immediate need for action through accident prevention on all highway systems in Massachusetts.

Local roads in the Non-Federal Aid System deserve special consideration in the urban areas. Since many accidents are occurring in the cities of the Commonwealth this problem should be given special attention.

In the Federal Aid Primary System, State highways have a decidedly lower average accident rate than that on the local roads. Nevertheless, both represent large economic losses sustained through highway accidents.

In the Federal Aid Secondary System, the State highways have a high accident rate and also involve high economic losses.

On the brighter side, it is evident that in the State Highway System, the highways with full control of access experience much lower accident rates, at a given volume, than do those highways where access is uncontrolled. Economic losses are also comparatively low on the controlled access roads.

In summary then, this study indicates the need for accelerated efforts in accident prevention from the viewpoint of reducing personal injuries and economic losses as well. In addition, it pinpoints

Continued

the highway systems where, through road construction and reconstruction, traffic control, enforcement and other means, remedial measures should be given priority.



